Ethernet Fundamentals

Ethernet Overview

Ethernet is now the dominant LAN technology in the world.

Ethernet is not one technology but a family of LAN technologies.

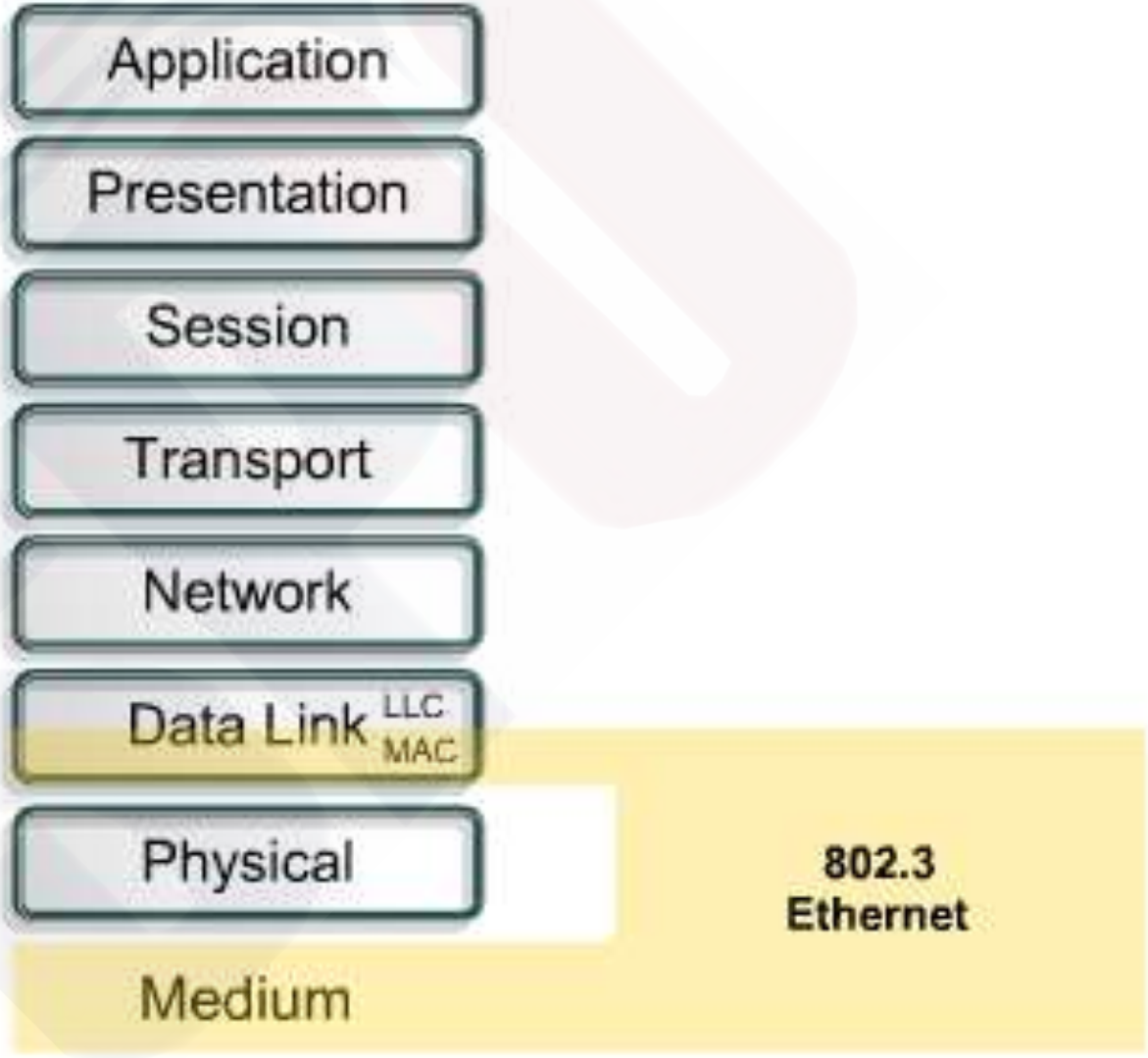
All LANs must deal with the basic issue of how individual stations (nodes) are named, and Ethernet is no exception.

Ethernet specifications support different media, bandwidths, and other Layer 1 and 2 variations.

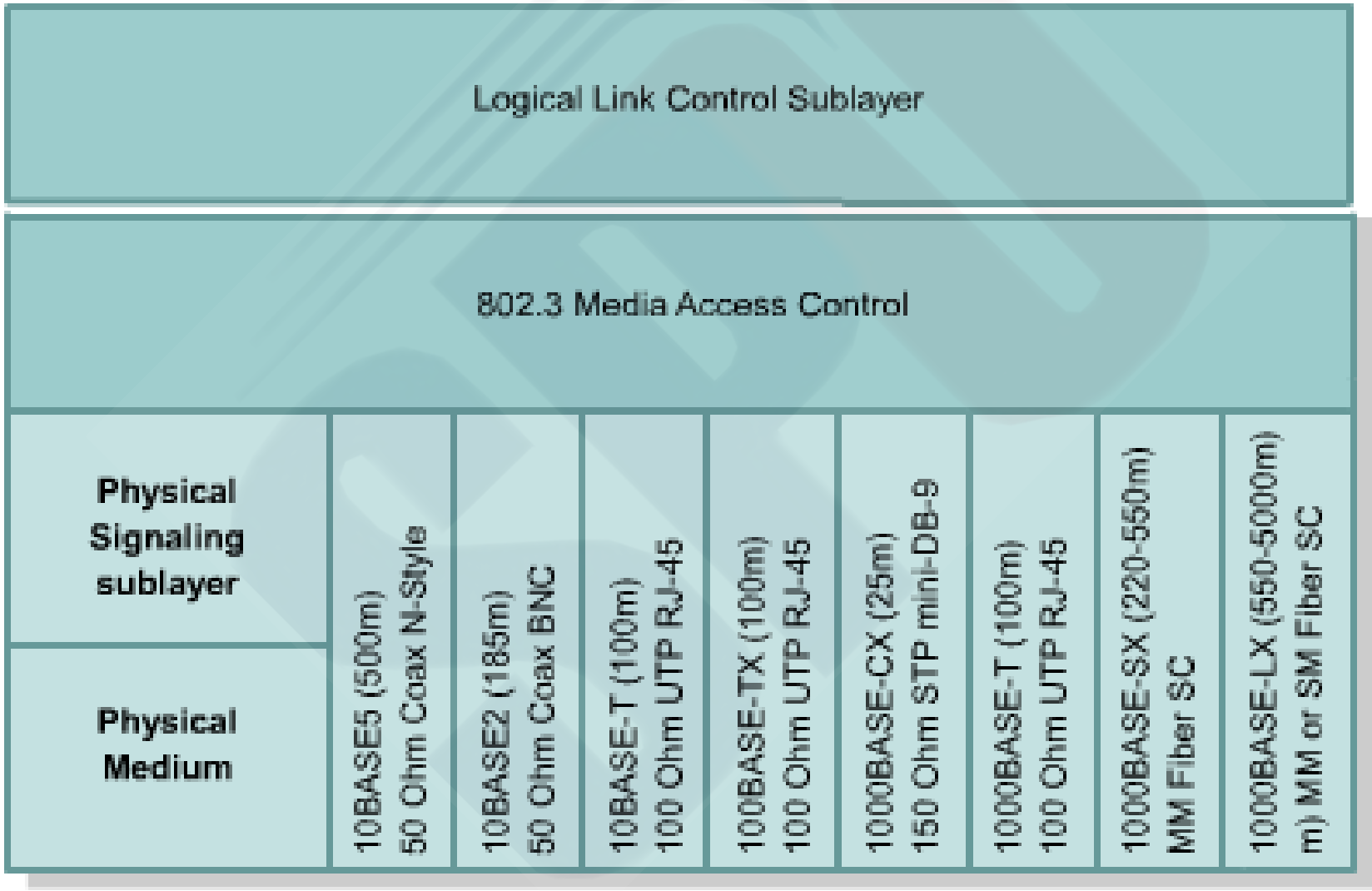
However, the basic frame format and addressing scheme is the same for all varieties of Ethernet.

Ethernet and the OSI Model

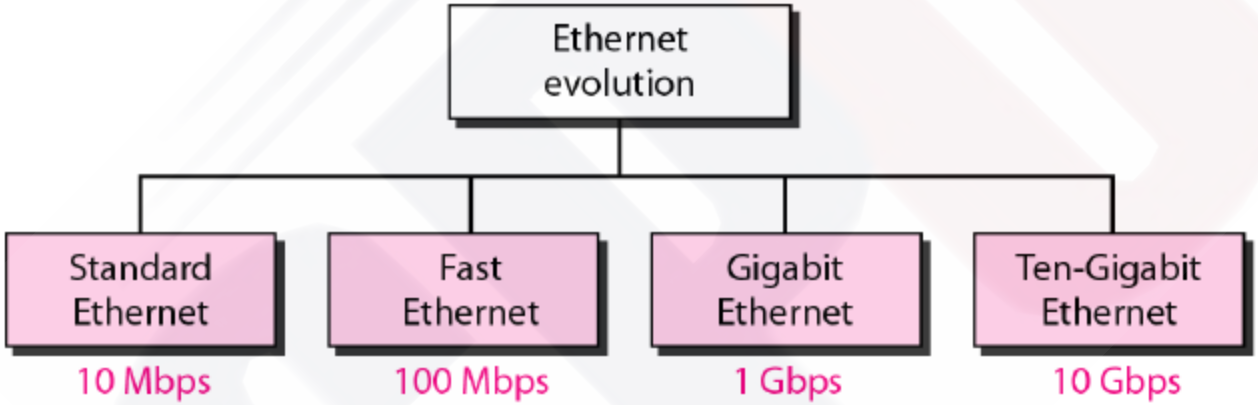
Ethernet operates in two areas of the OSI model, the lower half of the data link layer, known as the MAC sublayer and the physical layer



Ethernet Technologies Mapped to the OSI Model



Ethernet evolution through four generations



Layer 2 Framing

Framing is the Layer 2 encapsulation process.

A frame is the Layer 2 protocol data unit.

The frame format diagram shows different groupings of bits (fields) that perform other functions.

Field Names				
A	B	C	D	E
Start Frame Field	Address Field	Type/Length Field	Data Field	FCS Field

Ethernet and IEEE Frame Formats are Very Similar

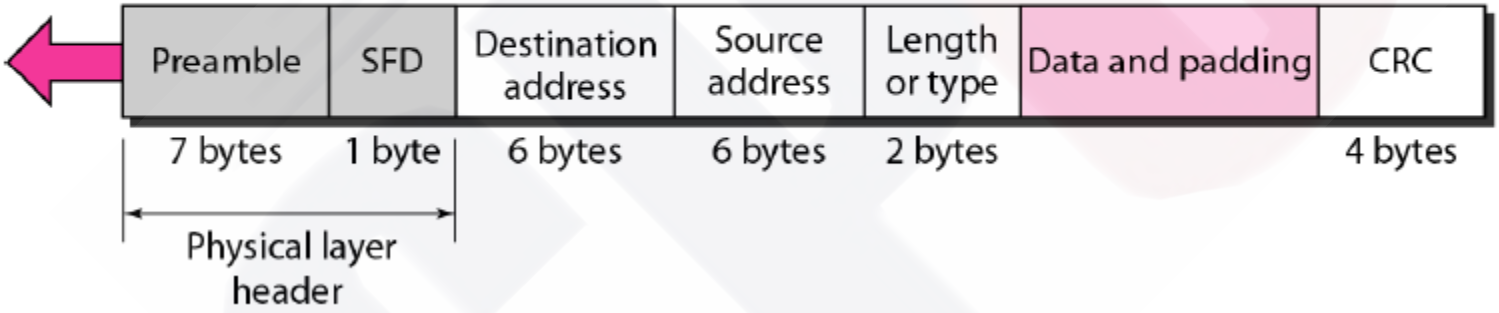
IEEE 802.3						
7	1	6	6	2	46 to 1500	4
Preamble	Start of Frame Delimeter	Destination Address	Source Address	Length/ Type	802.2 Header and Data	Frame Check Sequence

Ethernet					
8	6	6	2	46 to 1500	4
Preamble	Destination Address	Source Address	Type	Data	Frame Check Sequence

802.3 MAC frame

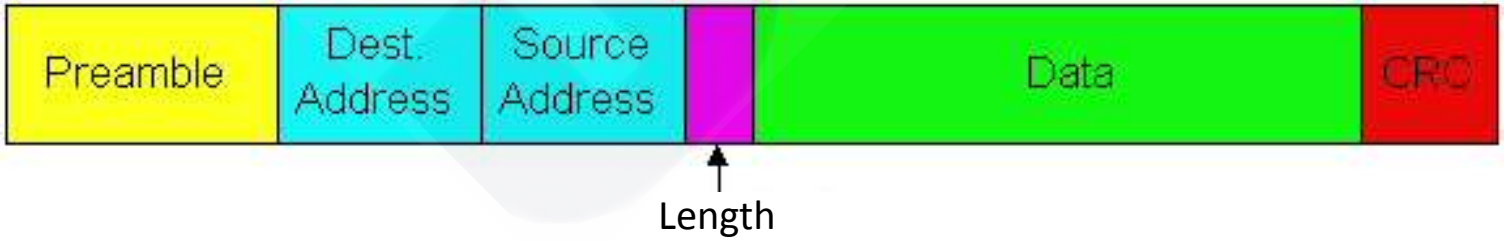
Preamble: 56 bits of alternating 1s and 0s.

SFD: Start frame delimiter, flag (10101011)

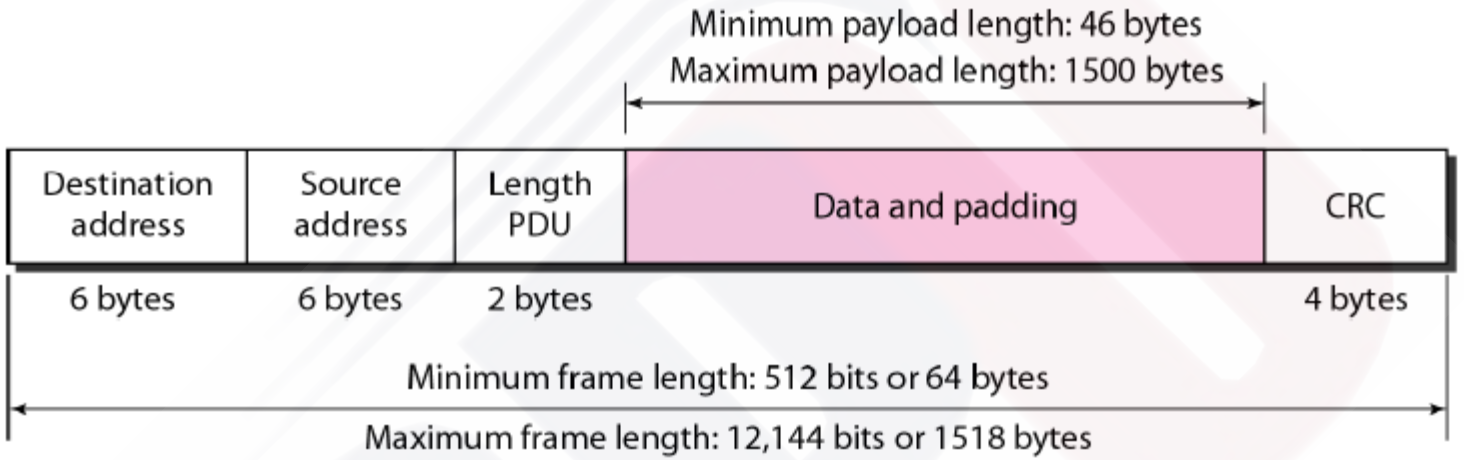


Ethernet Frame Structure

- **Preamble:**
  - 7 bytes with pattern 10101010 followed by one byte with pattern 10101011
  - Used to synchronize receiver, sender clock rates
- **Addresses:** 6 bytes, frame is received by all adapters on a LAN and dropped if address does not match
- **Length:** 2 bytes, length of Data field
- **CRC:** 4 bytes generated using CRC-32, checked at receiver, if error is detected, the frame is simply dropped
- **Data Payload:** Maximum 1500 bytes, minimum 46 bytes
  - If data is less than 46 bytes, pad with zeros to 46 bytes



Minimum and maximum lengths



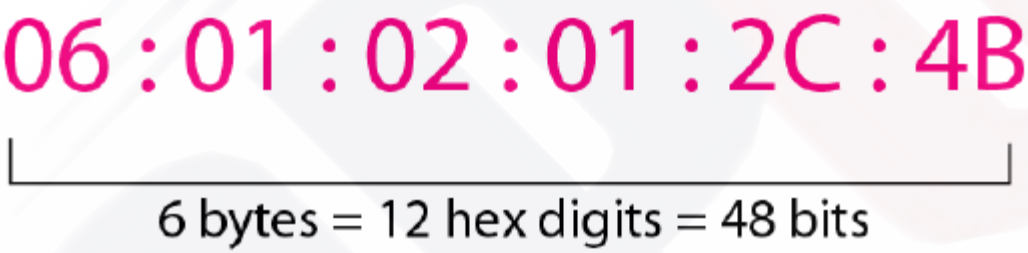
Note

Frame length:

Minimum: 64 bytes (512 bits)

Maximum: 1518 bytes (12,144 bits)

Example of an Ethernet address in hexadecimal notation



Unicast and multicast addresses

Note

The least significant bit of the first byte defines the type of address. If the bit is 0, the address is unicast; otherwise, it is multicast.

Note

The broadcast destination address is a special case of the multicast address in which all bits are 1s.

Example

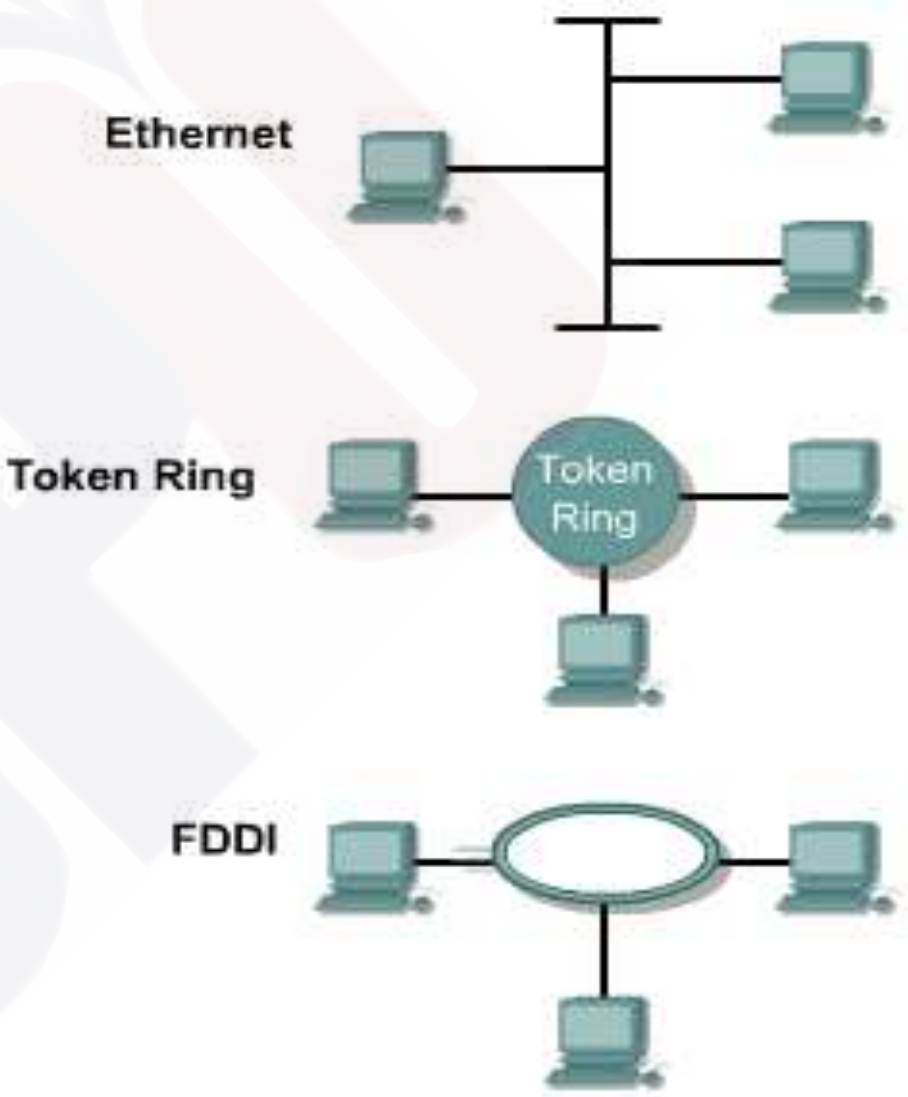
- ***Define the type of the following destination addresses:***
- ***4A:30:10:21:10:1A :::::::: unicast?***
- ***47:20:1B:2E:08:EE >>>>>>> multicast?***
- ***FF:FF:FF:FF:FF:FF ========== broadcast?***

3 Common Layer 2 Technologies

Ethernet
Uses CSMA/CD logical bus topology (information flow is on a linear bus) physical star or extended star (wired as a star)

Token Ring
logical ring topology (information flow is controlled in a ring) and a physical star topology (in other words, it is wired as a star)

FDDI
logical ring topology (information flow is controlled in a ring) and physical dual-ring topology(wired as a dual-ring)

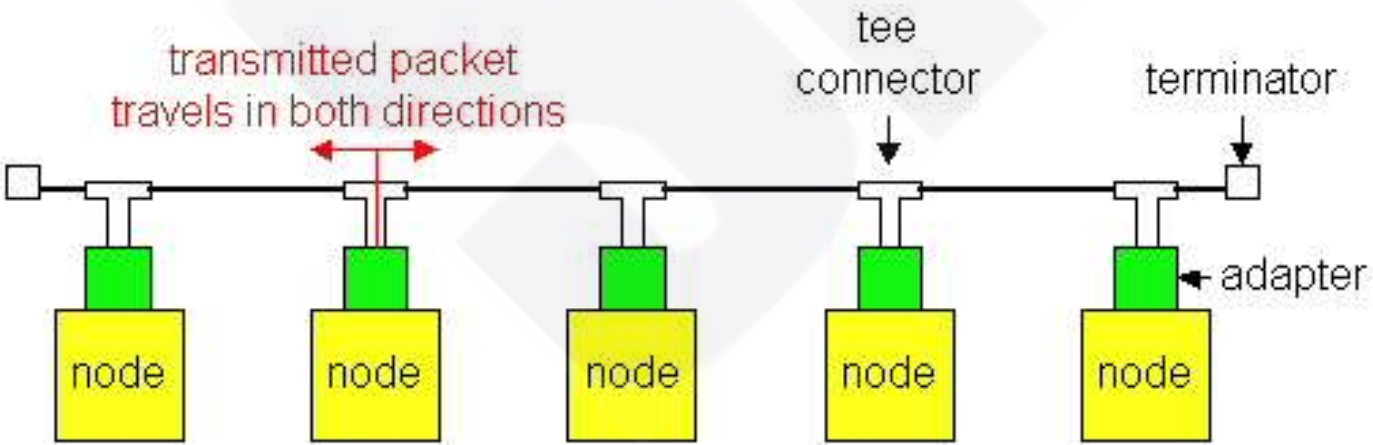


Technology Options

- Ethernet
- Fast Ethernet
- Gigabit Ethernet
- 10 Gig Ethernet
- WLAN

Media Access

- **Ethernet and Wi-Fi are both "multi-access" technologies**
  - Broadcast medium, shared by many hosts
  - Simultaneous transmissions will result in collisions
- **Media Access Control (MAC) protocol required**
  - Rules on how to share medium
- **The Data Link Layer is divided into two Part MAC Media Access Control) Sublayer and LLC (Logic Link Control) Sublayer**



802.3 Ethernet

- **Carrier-sense multiple access with collision detection (CSMA/CD).**
  - CS = carrier sense
  - MA = multiple access
  - CD = collision detection
- **Base Ethernet standard is 10 Mbps.**
  - 100Mbps, 1Gbps, 10Gbps standards came later

Ethernet CSMA/CD

- **CSMA/CD (carrier sense multiple access with collision detection) media access protocol is used.**
  - Data is transmitted in the form of packets.
  - Sense channel prior to actual packet transmission.
  - Transmit packet only if channel is sensed idle; else, defer the transmission until channel becomes idle.
  - After packet transmission is started, the node monitors its own transmission to see if the packet has experienced a collision.
  - If the packet is observed to be undergoing a collision, the transmission is aborted and the packet is retransmitted after a random interval of time using Binary Exponential Backoff algorithm.

Ethernet Address

- End nodes are identified by their Ethernet Addresses (MAC Address or Hardware Address) which is a unique 6 Byte address.
- MAC Address is represented in Hexa Decimal format e.g 00:05:5D:FE:10:0A
- The first 3 bytes identify a vendor (also called prefix) and the last 3 bytes are unique for every host or device

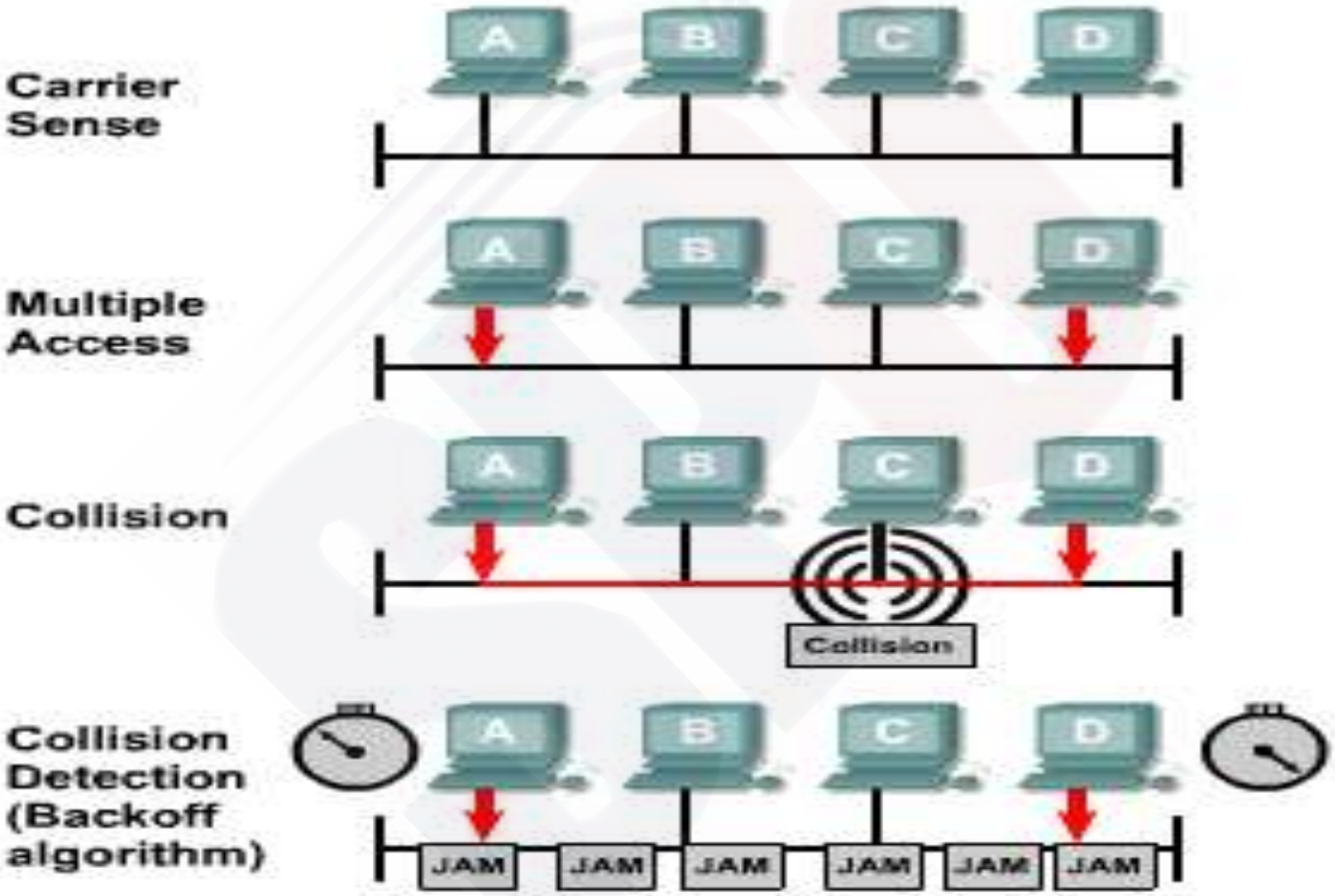
Collision Domains

To move data between one Ethernet station and another, the data often passes through a repeater.

All other stations in the same collision domain see traffic that passes through a repeater.

A collision domain is then a shared resource. Problems originating in one part of the collision domain will usually impact the entire collision domain.

CSMA/CD Graphic



Backoff

After a collision occurs and all stations allow the cable to become idle (each waits the full interframe spacing), then the stations that collided must wait an additional and potentially progressively longer period of time before attempting to retransmit the collided frame.

The waiting period is intentionally designed to be random so that two stations do not delay for the same amount of time before retransmitting, which would result in more collisions.